



Taxation as a Health Policy Instrument

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Published in:
Empiria: Journal for Students of Economics

Publication date:
2011

Citation for published version (APA):
Munk-Nielsen, A. I., & Riis-Vestergaard Sørensen, J. (2011). Taxation as a Health Policy Instrument. *Empiria: Journal for Students of Economics*, 1(1), 1-14. [1].

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TAXATION AS A HEALTH POLICY INSTRUMENT

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^{}Submitted as bachelor thesis to the Department of Economics, University of Copenhagen, April 2010. Revised, translated and submitted to Empiria, October 11, 2010; revised and resubmitted to Empiria March 15, 2011.*

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Abstract

Over the last 20 years the number of overweight and obese has risen in Denmark as well as globally. More recently, it has been proposed in the media that a differentiated VAT should be employed in order to change people's dietary habits towards a more healthy diet. This paper seeks to analyse the welfare implications of using price instruments in health policy. We do this by estimating the Almost Ideal (AI) Demand System of Deaton and Muellbauer (1980a) and using the parameters to perform a counterfactual policy experiment where the VAT on sugary foods is increased by 12.5 percentage points. Implications are analysed in two ways; firstly, we estimate the aggregate welfare loss from the tax distortion to DKK 1.69 billion. This can be used by health professionals as a benchmark criterion for the monetized welfare gains from e.g. healthier diets. Secondly, since micro data has been employed it is possible to analyse the distribution of welfare losses on household level. We conclude that losses and gains appear to follow the same distribution. All in all, we find that VAT differentiation is a good instrument in Danish health policy.

1 Introduction

1.1 Motivation

Developments over the past 20 years clearly point in the direction of an obesity epidemic. From 1987 to 2005, the proportion of overweight in the Danish population has increased from 30.8% to 44.3% while the proportion of obese has risen even more drastically from 5.5% to 11.4%¹. The need for po-

litical action seems evident but it is not clear what path should be chosen. So far, the Danish response has been primarily in the form of information campaigns, but lately the idea of using taxation as a health policy instrument has been discussed in the media (see e.g. Forbrugerrådet (2007)) as well as academically (Jensen, Astrup, Haraldsdóttir, Frandsen, Holm, Jepsen, Kærgård, and Rosenørn (2007)).

The advantage of using taxation is that it would affect the entire target group. However, taxation generally distorts incentives and

¹Source:

<http://susy2.si-folkesundhed.dk/susy.aspx>.

thus creates a welfare loss which is not imposed by campaigns. The present paper contributes to this discussion by providing a quantitative estimate of the magnitude that such a welfare loss might have and by analysing the distribution of such costs. The latter is important since redistributing the welfare gains is potentially very difficult.

1.2 What's new

Our paper provides two major contributions; firstly, the model has not (to the authors' awareness) previously been estimated on the Danish Annual Household Survey data. These data are then merged with the very rich Danish register data which enable the use of typically unavailable but theoretically essential variables such as income. Secondly, we provide a quantitative analysis of the distortionary welfare loss that would arise from using taxation as a health policy instrument in Denmark. The latter is possible due to the fact that the Almost Ideal (AI) Demand System of Deaton and Muellbauer (1980a) is derived directly from an explicit cost function. We can then use the estimated parameters to perform a counterfactual policy experiment where we calculate each household's compensating variation (CV) from a VAT increase of 12.5 percentage points². We analyse two aspects of the household welfare losses; the aggregate size and the distribution. The most novel part is arguably the latter, which is made possible by using micro-level data and aggregate consumption categories to model household heterogeneity. This approach disregards within-category composition changes, and in this sense we rely heavily on Smed, Jensen,

and Denver (2007) who establish that these changes are indeed for the healthier³.

Overall, however, the study of obesity as a societal problem is interdisciplinary, and as such the present paper is meant to be used by policy makers in conjunction with health research.

1.3 Can taxation be efficient?

— An internalities-approach

Before estimating the model, however, we need to establish a theoretical framework within which imposing a tax on unhealthy foods is sensible. Recall that taxing individuals is generally inefficient. However, Dodd (2008) argues that in regard to eating unhealthy foods, agents might have present-biased preferences, meaning that they make choices they will later regret. In this sense, the unhealthy consumption may be viewed as a within-person externality, an *internality*⁴. In analogue to traditional externalities, the full cost of the behaviour is not realized by the agent and this gives rise to possible efficiency gains from taxation. See O'Donoghue and Rabin (1999) for a formal model with explicit requirements on preferences and behaviour where taxing unhealthy food products will be pareto optimal.

³Smed, Jensen, and Denver (2007) also estimate an AI model on a Danish data set, but their focus is on the *composition* of the diet resulting from using VAT as a health policy instrument. To do this they need highly detailed categories, but this yields too many corner solutions so they choose to work with aggregated consumption instead. However, this rules out modelling household heterogeneity, for which they rely on the descriptive work from Smed (2002).

⁴Herrnstein, Loewenstein, Prelec, and Vaughan Jr. (1993) provide comprehensive evidence of internalities being performed in controlled experiments.

²The CV is the monetary compensation required to keep utility constant after the price change.

2 Model overview

2.1 Notation

Vectors will be written in boldface and will always be thought of as columns. We will be working with K categories of goods and let the price of the k 'th good be denoted by p_k . Furthermore, x is total nominal expenditures, s_k is the share of expenditures used on the k 'th category and greek letters signify parameters to be estimated.

2.2 Model formulation

The Almost Ideal (AI) Demand System of Deaton and Muellbauer (1980a) is based on the Price Independent Generalized Logarithmic (PIGLOG) preference representation where the log cost function is a weighted average of two different price indices. From this structural model of preferences, the following estimation equation for the i 'th budget share, s_i , is derived under the assumption of utility maximization:

$$s_i = \alpha_i + \sum_{k=1}^K \gamma_{ik} \ln p_k + \beta_i \ln \left\{ \frac{x}{P} \right\}, \quad (2.1)$$

$$i = 1, \dots, K$$

where P is a price index defined by

$$\ln P \equiv \alpha_0 + \sum_{k=1}^K \alpha_k \ln p_k + \frac{1}{2} \sum_{k=1}^K \sum_{j=1}^K \gamma_{kj} \ln p_k \ln p_j.$$

The reader is referred to Deaton and Muellbauer (1980b) for a detailed derivation. It can

be shown that the γ_{ik} 's will have approximately the same sign as the cross-price elasticities; however, the exact formulas for these will be given in section 5.2.

Note that (2.1) is inherently non-linear due to the parameters in P which appear in the term $\beta_i(\ln x - \ln P)$ all being multiplied by β_i . As Deaton and Muellbauer (1980a), we will deal with this by replacing P with a linear approximation to avoid using non-linear methods.

Since (2.1) may hold even if the structural model of preferences on which it is based is incorrect, we may think of the parameters in the simple OLS way. For instance, γ_{ik} is the semi-elasticity of budget share of good i with respect to the price of good k .

2.2.1 Theoretical restrictions

Standard economic theory rules out certain irrational patterns (which are deemed "irrational"). Specifically, we will require the model to satisfy the properties of adding up, homogeneity, and Slutsky-symmetry. Adding up is imposed at estimation⁵ whereas homogeneity and symmetry are tested as linear restrictions on the coefficients in a Wald-type test⁶. However, in practice the validity of these tests is questionable and often they are imposed at estimation (see e.g. Buse (1994); Blundell, Pashardes, and Weber (1993)) so we will not pay much attention to them.

⁵In particular, we leave out the last equation, fixing coefficients so that they satisfy $\sum_{k=1}^K \alpha_k = 1$, $\sum_{k=1}^K \beta_k = 0$ and $\sum_{k=1}^K \gamma_{kj} = 0$.

⁶Homogeneity means that $\sum_{k=1}^K \gamma_{jk} = 0$ for $j = 1, \dots, K$ and symmetry means that $\gamma_{kj} = \gamma_{jk}$ for all pairs $k, j = 1, \dots, K$.

3 Data

3.1 *The Danish Household Budget Survey*

The consumption data used in the present paper are from the Danish Household Budget Survey⁷, which is conducted by Statistics Denmark and are courtesy of the Rockwool Research Unit. The data used cover the period 1997–2005 giving us an effective sample of about 7,700 households. A unique feature is that the data are merged onto the comprehensive Danish register data which for instance give us access to income, labour market status, marital status, etc.

For price information we used the monthly EU-harmonized consumer price index for the groups matching our chosen categories (cf. section 3.2). This is similar to many other demand analyses (see e.g. Banks, Blundell, and Lewbel (1997); Deaton and Muellbauer (1980a)) but differs from Smed, Jensen, and Denver (2007) who observe the actual price paid in their data set.

3.2 *Choice of categories*

When choosing the level of detail, one must balance two trade-offs: Categories must be sufficiently detailed for consumption behaviour to be homogenous and sufficiently general to avoid too many households with zero consumption⁸.

We choose to work with four categories of food; sugar-based (“candy”), fruit, vegetables, and other foods. The idea is that we are able to distinguish between healthy and

unhealthy foods. The idea is that we — to some degree — are able to distinguish between healthy and unhealthy food. Splitting vegetables and fruit is perhaps the most controversial, but we found that the consumption behaviour for these groups was too different to justify joint modelling. In addition to these, we use six other categories⁹ for the system to be complete but since they were separable from food consumption, we exclude them from the exposition altogether.

3.3 *Descriptive analysis*

Figures 1 and 2 show the development in prices and shares for the most relevant consumption categories — interested readers are referred to Statistics Denmark for further details. To accommodate space constraints we exclude any detailed analysis. However, noting the high volatility of all series, we have performed a simple analysis of the correlation structure between the pairs of prices and quantities. For fruit and to some extent for vegetables we even found positive correlation. This is interpreted as an indication of the importance of handling heterogeneity explicitly, and thus we take advantage of the data set and include a wide range of demographic variables.

4 Estimation

4.1 *Linearisation*

Like Deaton and Muellbauer (1980a) we choose to approximate the price index $\ln P$ in (2.1) with the Stone Price Index given as

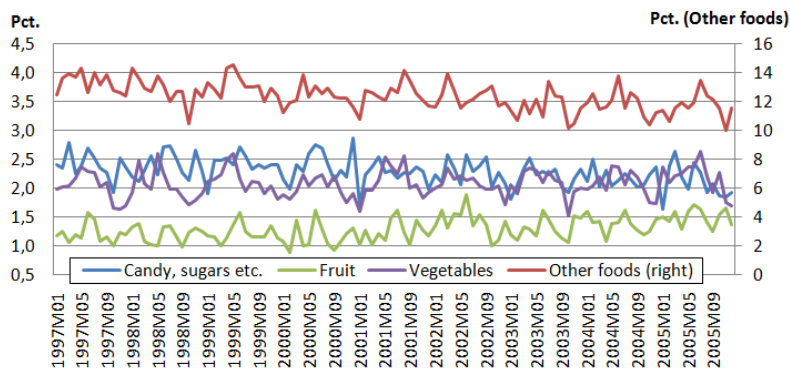
$$\ln P^* = \sum_{k=1}^K s_k \ln p_k \quad (4.1)$$

⁹These are Alcohol and Tobacco, Clothing and Footwear, Housing, Electricity and Heating, Communication, Other Goods and Services.

⁷An extensive description is given online;

www.dst.dk/Vejviser/Portal/Forbrug/Baggrundsinfo.aspx

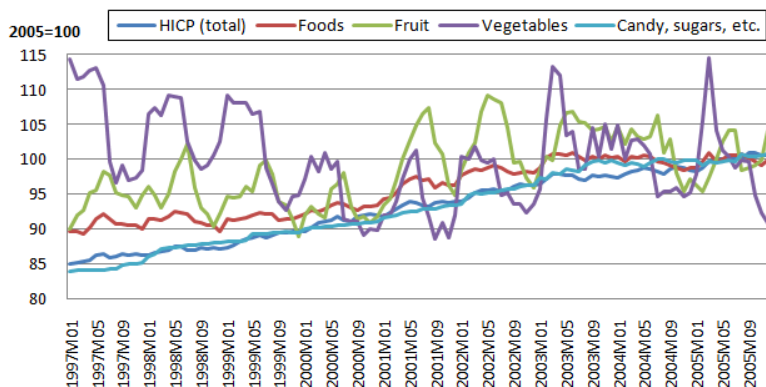
⁸Essentially we are working with a censored regression since households are unable to choose negative budget shares. Barslund (2007) handles this in a Tobit-type framework, but we follow the rest of the literature and ignore the problem to avoid non-linear estimation.



Source: The House Hold Surveys from 1998, 2001 og 2004 and own calculations.

Remark: The series have been calculated as shares of total consumption in selected categories.

Figure 1: Development in the consumption of candy, fruit, and vegetables, as shares of total consumption



Source: www.statistikbanken.dk/pris5

Figure 2: Price development for selected categories

Note that since prices differ between households, so will the price index.

Another approach would be to estimate the full model (2.1) directly using non-linear methods. This approach has the advantage that the exact model is estimated instead of a linear approximation and — as we will discuss in section 4.2 — there is no need for instrumental variables. On the other hand the model has very many parameters and thus optimisation routines will be quite demanding. Since an instrument is readily available, we choose the linearised specification.

4.2 *Instrumental variables approach*

Since the budget shares appear in the Stone price index, we get an equation in which the explained variable appears on both sides, leading to an endogeneity problem. We choose to follow Banks, Blundell, and Lewbel (1997) and use income as an instrument for the deflated total expenditures. The argument for the *exogeneity* of income is usually based on an assumption of intertemporal separability and it is widely discussed in the literature¹⁰. Often, however, income is not available which is why many authors make no mention of it — in this sense our data set enables us to go further than many others given that exogeneity holds. The instrument turned out to be *relevant* empirically.

4.3 *Control variables*

We allow demographics to influence the explanatory variables only through the inter-

cept and thus assume that no significant interaction effects are present¹¹. In the following, we briefly argue for the inclusion of the most important demographic variables individually.

Smed (2002) presents evidence that age (age) is important, and following Banks, Blundell, and Lewbel (1997) we also include age squared (agesq). Number of individuals will most likely play a part, and therefore we include the number of adult equivalents (adultequivs) as calculated by Statistics Denmark. Blundell, Pashardes, and Weber (1993) argue that the presence of children (haskids) may have an effect on behaviour apart from the sheer increase in household size, e.g. in terms of requiring more accountability. Browning and Meghir (1991) present ample evidence of bias resulting from the exclusion of labour market status (employed) so we include a dummy for employment. Lastly, we choose to include dummies for education level (educ2 for high school level and educ3 for post secondary); like Smed (2002), we believe that educated people are better able to gather information and thus learn about consequences of unhealthy dietary habits, which would cause them to change their diets¹².

4.4 *Estimation equation*

Summing up, we can now state our estimation equation, which we write for the i 'th

¹⁰See e.g. Deaton and Muellbauer (1980b). Lewbel and Pendakur (2009) moreover mention that one problem with using income is that it does not account for dynamic aspects and that wealth would thus be a better instrument. This was, however, not possible in our study due to data issues.

¹¹This was tested to some extent (the number of parameters increases immensely when interactions are included) and we found no important evidence against the choice.

¹²Others such as Browning and Meghir (1991) view education as an indicator for taste and use it as an instrument instead.

category for household $h = 1, \dots, H$ as

$$s_{ih} = \alpha_i + \sum_{k=1}^K \gamma_{ik} \ln p_{kh} + \beta_i \ln \left\{ \frac{x_h}{P_h^*} \right\} \quad (4.2)$$

$$+ \sum_{l=1}^L \theta_l C_l + \varepsilon_{ih} \quad i = 1, \dots, K$$

where $\ln P_h^*$ is the price-index defined in (4.1) and (C_1, \dots, C_L) denote the L demographic variables used. The equation will be estimated with a 3 Stage Least Squares (3SLS) estimator as implemented in STATA's `reg3` procedure. We will be using household income as an instrument for $\ln\{x_h/P_h^*\}$ to solve the endogeneity problem. We also supply tests for the restrictions of homogeneity and symmetry (as mentioned in section 2.2.1), both of which are implemented as standard Wald tests since the restrictions are linear.

5 Results

In this section, we present the most important estimates for the model (4.2). The model has 260 coefficients, so we will focus on those relevant to the food categories as the remaining categories are only included to ensure a consistent demand system. Overall we found that a very general setting with many demographic variables gave more plausible estimates.

5.1 Results from the final model

Table 1 presents a selection of the parameter estimates for the final model.

The first five rows are of primary interest in our analysis, but we will discuss these in more detail when we calculate the price and budget elasticities in section 5.2. However,

we note that the share of fruit varies positively with the price of fruit.

We turn to the demographics. Firstly, we note that homogeneity is accepted but symmetry is rejected, which is in line with the literature. Secondly, we see that $\ln x$ - Real (i.e. β_i in eq. (4.2)) is significantly negative for all four food categories, labelling these as necessities. This is in accordance with standard theory. Our budget coefficient for the large food category, Other Foods, (-0.056) is significantly smaller than what Jensen and Toft-kær (2002) find in another Danish data set (-0.116). However, we both find that no prices are significant in that equation.

The quarterly dummies are included to handle seasonality and although they are insignificant, excluding them led to unsatisfactory modelling of the equations for fruit and vegetables. Since these two goods in particular are affected by seasonality, we conclude that their exclusion results in an endogeneity problem and hence we keep them. A more adequate description of the goods, including e.g. quality of the fruit, would be preferable but this is not available in our data set.

Generally, we find that demographics affects consumption in a way consistent with economic theory. In particular, we note that the presence of children only affects candy (increasing it) even after correction for the number of individuals. Since it does not increase consumption of healthy food, we see no evidence in support of a more responsible behaviour in response to having children.

5.2 Comparison with the literature

In order to provide a better basis for assessing the validity of the results, we now

Table 1: PARAMETER ESTIMATES FOR THE FOUR FOOD EQUATIONS

	Equation:			
	Candy	Fruit	Vegetables	Other foods
priceCandy	-0.00183	-0.03001	-0.00827	-0.04095
priceFruit	-0.00167	0.01948**	0.00044	-0.03613
priceVegetables	0.01376*	0.00822	0.01540**	-0.00716
priceOtherfoods	0.01931	-0.01184	0.01530	0.16503
lnxReal	-0.00964***	-0.00448***	-0.00784***	-0.05624***
Quarter2	0.00023	0.00039	0.00120	-0.00183
Quarter3	0.00073	-0.00070	0.00065	-0.00131
Quarter4	0.00030	0.00132	-0.00127	-0.00921***
employed	0.00215*	0.00023	-0.00036	0.00004
hoursworked	-0.00003	-0.00001	0.00000	-0.00001
single	-0.00261**	-0.00196**	-0.00698***	-0.03174***
haskids	0.00390***	0.00026	0.00015	0.00918***
singlewithkids	0.00348**	0.00090	0.00250**	0.01558***
age	-0.00016	0.00010	0.00049***	0.00262***
agesq	0.00000	0.00000	0.00000***	-0.00002***
male	-0.00214***	-0.00243***	-0.00235***	0.00478***
adulthequivs	0.00980***	0.00435***	0.00364***	0.03055***
educ2	0.00034	0.00023	0.00069*	0.00033
educ3	0.00048	0.00207***	0.00231***	0.00061
_cons	-0.01610	-0.00321	-0.01951	0.73425
TESTS				
H_0 : Homogeneity	$\xi_{\text{Hom}} = 14.91 \stackrel{a}{\sim} \chi^2(9)$, $p = 0.0935$			
H_0 : Symmetry	$\xi_{\text{Sym}} = 132.03 \stackrel{a}{\sim} \chi^2(36)$, $p < 0.0001$			
*: $p < 5\%$, **: $p < 1\%$, ***: $p < 0.1\%$				

calculate¹³ the own-price elasticities (ϵ) and budget elasticities (ρ) and compare them to what other researchers have found. As Banks, Blundell, and Lewbel (1997), we report a weighted average of the households' elasticities using their share of total expenditures as weights. The standard errors are complicated functions of the parameters involved and will not be calculated here, although they could also be obtained from bootstrapping methods, for example.

We note that we are comparing our results to studies somewhat different from our own. However, each study maintains that it identifies the same fundamental behavioural parameters. Most importantly, it should be noted that all studies considered in table 2 below except Blundell, Pashardes, and Weber (1993) are based on *aggregated categories*. This ensures fewer corner solutions but has the disadvantage that heterogeneity cannot be controlled for.

Candy: Our ϵ (own-price elasticity) estimate seems plausible whereas our ρ (budget elasticity) is difficult to assess but seems plausible.

Fruit: Although the ρ estimate is very close to that of Jensen and Toftkær (2002), we get a *positive* ϵ estimate. We view this as a failure to handle the fruit category properly, and we believe that the source is the missing information on product quality¹⁴.

Vegetables: Our estimate of ρ seems plausible

whereas our ϵ estimate is numerically smaller than what others have found. However, we found parameter estimates in this equation to be particularly sensitive to the inclusion of demographics, indicating that the disadvantage in aggregated analyses from not modelling heterogeneity (e.g. education) might be particularly bad here.

Other foods: This is the largest category used in our study. We find a ρ coefficient close to that of Blundell, Pashardes, and Weber (1993) although our ϵ estimate is half the magnitude they find. However, given that this category is much larger and less homogenous, these results may stem from the lack of a precise price index for this “residual category”.

5.3 Conclusion

The model appears to handle the consumption of the candy category satisfactorily. The fruit category is not satisfactorily modelled, but since its cross-price is insignificant we may in the following focus on candy alone.

6 Welfare analysis and policy experiment

In this section we perform a counterfactual policy analysis using the estimated coefficients from table 1.

6.1 Calculating the welfare loss

We consider an increase in the price of candy of 10 pct. which would correspond to an increase in the VAT on candy of 12.5 pct. points. We want an increase that is sizable enough to give a reaction while still respecting that we are using a linear model¹⁵. We

¹³Like Jensen and Toftkær (2002) and Smed, Jensen, and Denver (2007) we calculate them as $\rho_{ih} = 1 + \beta_i / s_{ih}$ and $\epsilon_{ih} = (\gamma_{ii} - \beta_i [\beta_i \ln(x_h / P_h) - s_{ih} - \gamma_{ii} \ln p_{ih}]) / s_{ih} - 1$.

¹⁴Although there may have been behavioural changes in the period since the results were highly sensitive to the introduction of seasonal dummies. One reason could be the health campaign “6 om dagen” which was launched in 2001.

¹⁵For comparison, Banks, Blundell, and Lewbel (1997) consider a VAT increase on clothes of 17.5 pct. points, but they employ quadratics in a non-linear framework which may be better suited to handling larger increases.

Table 2: OWN-PRICE ELASTICITIES (ϵ) AND BUDGET ELASTICITIES (ρ)

	Candy		Fruit		Vegetables		Other Foods	
	ϵ	ρ	ϵ	ρ	ϵ	ρ	ϵ	ρ
Our results	-1.1124	0.5956	0.3803	0.1672	-0.33312	0.6321	-0.2550	0.5451
Smed, Jensen, and Denver (2007)	[-1.3;-0.6]	.	[-1.7;-0.4]	.	[-1.5;-0.9]	.	.	.
Jensen and Toftkær (2002)	-1.01	0.163	-0.807	0.172	-0.807	0.172	-0.38	0.20
Edgerton (1997)	0.68	-0.57	-0.63	0.66	-0.63	0.66	.	.
Blundell, Pashardes, and Weber (1993)	-0.514	0.501

A “.” indicates that the estimate in question is not provided in the paper.

Smed and Denver (2004) report estimates for different social groups separately. We present the range they fall in.

Jensen and Toftkær (2002) use one group for fruit and vegetables together.

Edgerton (1997) also uses one group for fruit and vegetables together.

are not modelling the supply side and thus implicitly assume that the tax increase is absorbed completely into the prices. Jensen, Astrup, Haraldsdóttir, Frandsen, Holm, Jepsen, Kærgård, and Rosenørn (2007) argue that this is in fact a reasonable assumption in a Danish context.

Deaton and Muellbauer (1980a) derive the estimation equation (1.3) directly from an explicit cost function. By plugging our estimated coefficients into this we are able to calculate the *compensating variation*, CV_h , for each individual household for a given change in the prices¹⁶. We can then use the weights of representativeness from the data set to aggregate from our sample to the total Danish population. Thus, we estimate total CV to DKK 2.48 billion.

¹⁶To be precise we calculate it as $CV_h(x, \mathbf{p}^0, \mathbf{p}^1) \equiv c(\psi(x, \mathbf{p}^0), \mathbf{p}^1) - c(\psi(x, \mathbf{p}^0), \mathbf{p}^0)$, where $c(\cdot)$ is the (log) cost function given in eq. (1) of Deaton and Muellbauer (1980a) and $\psi(\cdot)$ is the indirect utility function given as $\psi(x, \mathbf{p}) \equiv (\ln x - \ln a(\mathbf{p})) / \ln b(\mathbf{p})$, where $a(\cdot)$ and $b(\cdot)$ are the price indices given as eq. (2) and (3) of Deaton and Muellbauer (1980a).

However, the higher VAT will generate a higher tax revenue, which is a welfare gain as it can be used, for example, to reduce harmful income taxes (although we will assume that DKK 1 of tax revenue will generate exactly DKK 1 of welfare). Using the formula of (Varian, 2006, p. 275) and the substitution patterns derived from the estimated elasticities, we find that the policy will imply an increase in tax revenue of DKK 0.79 billion¹⁷.

The resulting welfare loss in billion DKK can now be calculated as:

$$\begin{aligned} \text{Total welfare loss} &= CV_{\text{total}} - \Delta T \\ &= 2.48 - 0.79 = 1.69 \end{aligned}$$

¹⁷Let ΔT be the change in tax revenue, $\Delta \tau$ the change in tax rate on candy in percentage points, q_{candy}^0 the total quantity of candy consumed at time 0, \bar{p}_{candy}^0 the weighted average of prices at time 0 and $\bar{\epsilon}_{\text{candy}}$ the weighted average of own-price elasticities of candy. Then

$$\Delta T = \Delta \tau \cdot \bar{p}_{\text{candy}}^1 \cdot q_{\text{candy}}^1 = 0.125 \cdot 1.1 \bar{p}_{\text{candy}}^0 \cdot (1 + 0.1 \bar{\epsilon}_{\text{candy}}) q_{\text{candy}}^0$$

This tells us that the policy on a yearly basis must generate DKK 1.69 billion in welfare improvements for the total effect to be zero. Such gains would have to come primarily from an improved public health in which for example externalities as described in section 1.3 would be addressed. If the gains exceed 1.69 billion *and* the policy maker can redistribute the welfare gains without costs, the policy will be pareto efficient.

6.2 Taking heterogeneity into account

The assumption of cost-free redistribution of the welfare gains is particularly unrealistic in the present context as it is excessively difficult to assess the size of a given individual's loss — whether the individual is unhealthy because it is cheap to be so or because he prefers to be so. The Coase Theorem also fails as we cannot enable present individuals to trade with their future selves (see Dodd (2008), for an elaboration). Furthermore, it would presumably be politically infeasible to pay back households differently in practice. Hence, it is relevant to analyse a setting where the state is unable to take consumer heterogeneity into account when designing the pay back scheme. We choose to look at a situation where the entire amount is paid back as a lump sum to each household¹⁸. This means that each household will receive DKK 0.79 billion / 2.47 million Danish households \cong DKK 316.

It would be natural to compare this with an estimate of each household's welfare gain; however, no such estimate is readily available. To assess the distributional aspects of

the policy we choose instead to look at a benchmark case in which the welfare gains are of a magnitude such that the net welfare change is zero, i.e. the welfare gains amount to DKK 1.69 billion. We have tried using different household characteristics to display the distribution but have found that the age of the household head captures almost all relevant aspects.

6.2.1 Uniformly distributed welfare gains

We first analyse a setting in which the gains are uniformly distributed across households. Each household must then have a monetised gain of DKK 1,690 / 2.47 million Danish house-

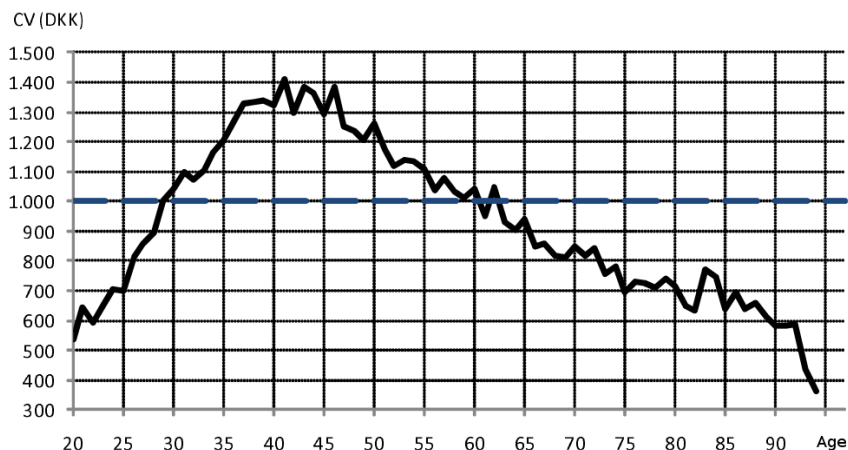
holds \cong DKK 684. Figure 3 shows the average CV for each age category and the dashed (blue) line indicates the total welfare gain, which is the same for all households in this setting.

We see that under the given assumptions, households with household head aged 30–60 will suffer a net loss whereas those below 30 and above 60 will experience a net gain. It is clear that this result depends crucially on the fact that tax refunds are uniform over households. If instead these were chosen to depend on the number of individuals in the household, it is clear that families with children would receive larger refunds whereas the youngest and oldest on average would receive less. This would point further in the direction that gains and losses are consistent.

6.2.2 Non-uniformly distributed welfare gains

It seems reasonable that the welfare gains would instead follow some non-uniform distribution. The closer this distribution of the gains (the dashed line in figure 3) is to that of the losses (the black line) the less damag-

¹⁸Alternatively, one might choose to pay back a lump-sum to each *individual*, but since the model is estimated using households as the unit we choose the above approach.



Note: The dashed line indicates the level of the average compensating variation (DKK 1.003).

Data for household heads below 20 years of age is excluded due to the low number of observations.

Figure 3: AVERAGE COMPENSATING VARIATION (CV) BY AGE OF HOUSEHOLD HEAD

ing the payback scheme is¹⁹. However, since it lies beyond our professional expertise to make conjectures in that direction, we will instead use the focus groups of the Danish health campaign “6 om dagen” (En: 6 a day) as this campaign was designed by health professionals. The target groups are; men, young people, and families with children²⁰. Since families with children are usually in the age groups 30–45, welfare gains for this group appear to be consistent with the losses in figure 3. In contrast, young people have much smaller losses (cf. figure 3) meaning that they might experience excessively high net gains. Since we use the household as the basic uni-

ty, it does not make sense to split up by gender so we cannot see if men have higher losses. Lastly, we note that since the elderly are not in the target groups, it is fortunate that they also have smaller welfare losses. Summing up, our results appear to indicate that the welfare losses are distributed in accordance with the gains except for the youngest. However, this group is also relatively poor. In fact, further calculations showed that the youngest households experience the largest loss *relative to their income*, so perhaps it is also fair that they have a surplus welfare gain.

7 Conclusion

In this paper we have analysed the effect of a policy where the Danish VAT on candy would be increased by 12.5 pct. points. Our most firm conclusion is that the policy should never be implemented unless the total national

¹⁹This is of course for a given level of the *total* welfare gains, i.e. the *area* below the dashed line in figure 3. Naturally, if this is shifted up (down) vertically the policy becomes more (less) attractive.

²⁰See <http://6omdagen.dk/kampagne/bilag/6omdaggrundlag08.11.final.pdf>.

welfare gains exceed DKK 1.69 billion yearly. It lies beyond our professional expertise to conjecture as to the size of the welfare gains from healthier diets etc. as this belongs in health research. Moreover, we have analysed the distributional aspects of the welfare losses and compared these to a realistic conjecture based on the choice of focus group in a major Danish health campaign and concluded that household level gains and losses appear to be in agreement. This means that the implementation would be unlikely to require excessive reallocations, which is an important concern for the policy makers as this can be overly difficult or maybe even impossible.

Generally, the model was found to perform well in the sense that the derived elasticities were similar to the rest of the literature. The candy category was chosen as policy experiment as the model performed particularly well here. We acknowledge, however, that our model does not take dynamics into account and that a more satisfying model would consider the life-cycle dietary aspects. Also, it would be preferable to use a panel data set to handle unobserved individual specific effects but our data set was limited in this sense. Even so, we find no indication in our results or in the literature that our results should deviate excessively from the truth.

All in all, we conclude that taxation would be a sensible instrument in Danish health policy provided that aggregate yearly welfare gains are believed to exceed DKK 1.69 billion yearly.

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